State of Illinois
Department of Registration and Education
STATE GEOLOGICAL SURVEY DIVISION
Morris M. Leighton, Chief

GUIDE LEAFLET

GEOLOGICAL SCIENCE FIELD TRIP

Sponsored by
ILLINOIS STATE GEOLOGICAL SURVEY, URBANA

MONMOUTH AREA

Warren County

Monmouth and Alexis Quadrangles

Leaders
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Urbana, Illinois
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GUIDE LEAFLET 54 B HOST: Monmouth College

MONMOUTH GEOLOGICAL SCIENCE FIELD TRIP

Itinerary

0.0	0.0	Assemble along southwest side of drive east of McMichael Science Hall. Cars head southeast. On leaving, turn right (south) on Ninth Street.
0.1	0.1	STOP. East Broadway Rt. 34. Turn left (east).
0.2	0.3	Turn left (north) on highway.
0.3	0.6	Bear right (east).
0.4	1.0	Leave Monmouth.
0.9	1.9	Illinoian drift plain.
0.8	2.7	Leave highway -- straight ahead on gravel road.
0.7	3.4	Stop 1. Illinoian drift plain.

Hundreds of thousands of years ago most of Illinois and most of northern North America was covered by huge ice sheets or glaciers. These glaciers expanded from centers in what is now eastern Canada. They developed when for reasons not yet determined the mean annual temperatures in the region were somewhat lower than now, so that not all of the snow that fell during the winters was melted during the summers. The snow residues accumulated year after year until they became a sheet of ice so thick that, as a result of its weight, the lowermost part began to flow outward, carrying with it the soil and rocks on which it rested and over which it moved. The process continued until the glacier extended into our country as far south as the Missouri and Ohio Rivers.

Moderation of temperatures halted the glacier. For awhile the melting of the ice balanced its accumulation and expansion, so that its margin remained stationary. Later the melting exceeded the accumulation and expansion, and the ice front gradually melted back until the glacier disappeared entirely.

As the glacier melted, all of the soil and rocks which it had picked up as it advanced were released. Some of this material or <u>drift</u> was deposited in place as the ice melted. Such material consists of a thorough mixture of all kinds and sizes of rocks and is known as <u>till</u>. Some of the glacial drift was washed out with the melt waters. The coarsest <u>outwash</u> material was deposited nearest the ice front and gradually finer material farther away. The finest clay may have been carried all the way to the ocean. Where the outwash material was spread widely in front of the glacier, it forms an <u>outwash plain</u>; where it was restricted to the river valleys, it forms <u>valley trains</u>.

At times, especially in the winters, the outwash plains and valley trains were exposed as the melt waters subsided.

The wind picked up silt and fine sand from their surfaces, blew it across the country, and dropped it to form deposits of loess. Glacial loess mantles most of Illinois. Near the large river valleys it may be as much as 60 or 80 feet thick. Far from the valleys it may be measured only in inches, if it can be identified at all.

There were four major periods of glaciation during the Pleistocene or Great Ice Age (see accompanying table). Between each pair was a long interglacial period in which conditions were as they are today. During each major glaciation there were a number of retreats and readvances. This was particularly true during the last or Wisconsinan Glacial Age.

The Monmouth region, like the rest of Western Illinois, was invaded by the glaciers during the Kansan and Illinoian, or second and third, glacial ages. Glacial drift of these ages may be found in the region. Probably the region also was invaded by the Nebraskan or oldest glacier, although no materials positively of Nebraskan age have been identified. The Wisconsinan Glacial Stage is represented only by loess, which is a surficial mantle several feet thick.

Before the advent of the glaciers the surface of the Monmouth region was a series of soil-covered ridges and valleys eroded in bedrock. The topography was comparable to that of Jo Daviess County. However, the glacial deposits have altered the appearance considerably. Some of the preglacial valleys are completely filled with drift and obliterated. Others were more or less re-excavated during the interglacial stages, and some of the present valleys follow the preglacial valleys to some degree. In other cases the present stream which developed after glaciation cut into or across the preglacial rock ridges, and in such places good exposures of the bedrock may be found.

The position of the ice front at each advance of the glacier is usually marked by a ridge of till or moraine. The moraine represents the accumulation of drift at the ice margin while the advance and melting were essentially in balance and more and more material was being brought to the edge by the advancing ice. When melting exceeded advance causing the ice front to retreat, the resulting drift deposits formed a drift plain or till plain whose surface may be almost level or more or less billowy.

At this stop the Illinoian drift plain, with its mantle of Wisconsinan loess, is unusually flat. This condition is prevalent in the Monmouth region as is evident from the topographic maps of the area. Despite the time that has elapsed since Illinoian glaciations, much of the plain is not eroded. Thus the region may be considered to be in the late youth stage in the cycle of erosion.

However, most of the valleys in the area appear to be in a mature or submature stage of development because they have a wide U-shaped cross-section, gentle slopes, and a flat bottom of alluvium in which the stream is incised a few feet along a widely meandering channel.

2.0 5.4 Along south side of road is exposed a downward succession of Peorian Loess, Farmdale Loess, and Sangamon Soil profile on Illinoian drift.

0.5 5.9 Stop 2. On south side of road is exposed a downward succession of Peorian Loess with recent weathering profile, Roxana Loess, and Sangamon Soil profile on Illinoian till.

As has already been mentioned, the uppermost glacial deposits in the Monmouth region are loesses of Wisconsinan age, three in number. The latest, buff colored, has the present soil profile developed on it. The next, a gray loess, has no weathering profile because the time interval between the two upper loesses is too short. These loesses are the Richland Loess and the Morton Loess, respectively. They are grouped under the term Peoria Loess in areas where it is impossible to differentiate them.

The first and oldest Wisconsinan loess is the Roxana, typically chocolate brown in color. It is generally leached, presumably because it was deposited so slowly that it was leached as it was deposited. However, the time interval between the deposition of the Peoria and Roxana Loesses was sufficient that some humus and locally peaty or even woody material accumulated at the top of the Roxana Loess. Where the Roxana Loess is only a few inches thick and lies on well-developed Sangamon Soil, the two cannot be readily differentiated. The time intervals during which the Roxana and Peoria Loesses were deposited, are the Altonian and Woodfordian, respectively. The interval of humus accumulation between these two is called the Farmdalian.

Like many other things, rocks and minerals change when they are exposed to the weather. Although these changes are relatively slow, they become evident in earth deposits that are not disturbed over long periods of time and develop what is known as a weathering or soil profile in the surficial part of such deposits.

Following the practice established about 30 years ago by the Russian Glinka, soil scientists usually consider that the soil or weathering profile consists of 3 zones, designated A, B, and C from top down. The A zone is the "soil" zone, which is normally black or gray in color. The B zone is the "subsoil" zone, and the C zone is the unaltered "parent material."

The zonal effect results because the four principal processes which affect soil weathering all progress with the

downward movement of groundwater but at different rates. These processes, listed in order according to their rate of progress, beginning with the most rapid, are (1) oxidation, (2) leaching of carbonates, (3) decomposition of more resistant minerals, and (4) accumulation of humus.

Consequently in the A zone, in which the humus material derived from decaying plants has accumulated, the rock minerals are oxidized, leached, and decomposed. In the upper part of the B zone they are oxidized and leached and in the lower part of the B zone they are only oxidized. The oxidation zone is shown by the reddish or yellowish color resulting from the oxidation of iron minerals. The leached zone is determined by the absence of carbonates, as revealed by tests with a solution of hydrochloric acid.

The typical soil profile is developed on the Tazewell loess at this stop, although the loess is not thick enough to reveal everywhere the C zone at the bottom.

Below the Altonian deposits there is about 12 feet of Illinoian till greatly weathered during the succeeding Sangamon Interglacial Stage. Geologic studies of the soil profiles developed on the older drifts - Illinoian, Kansan, and Nebraskan - reveal that they can be divided into 5 zones, or horizons, instead of the 3 first recognized by Glinka in the soil profile developed on the Wisconsinan drift. In order to avoid confusion they have been designated by numbers instead of by letters.

Horizon 1 is the old "soil" or humus zone. Horizon 2 is a dense layer, very gummy and plastic when wet, very hard when dry. Horizon 3 is the leached and oxidized zone, and Horizon 4 is the oxidized but calcareous zone. Horizon 5 is the unaltered parent material.

The development of 5 instead of 3 recognizable zones in the old drifts results from the fact that they are much more weathered. The total thickness of the weathering on the old drifts is much greater than on the Wisconsinan drift, even where the older drifts are overlain by younger drifts. Oxidation, leaching, and decomposition of minerals have all progressed deeper. In addition, another process, the downward transfer of clay minerals derived from the decomposition of other minerals originally in the drifts, has not only left Horizon 1 more silty than it was originally but has made Horizon 2 much denser and more plastic than it was originally. This dense, plastic "gumbo" horizon is so little developed on Wisconsinan drift that it is not differentiated.

0.7	6.6	T-road. Turn left (north).
2.0	8.6	STOP. Rt. 34. CAUTION. Turn left (west) on highway.

3.4	12.0	SLOW. Bear left (south).
0.9	12.9	SLOW. Prepare to turn off highway.
0.3	13.2	Turn right (west) on gravel road.
1.6	14.8	Turn right (north).
0.5	15.3	Stop 3. If road conditions are dubious, the caravan will turn about at Mr. King's farmstead and park along the road headed south. If road conditions are favorable, the caravan will continue north for at least half a mile before turning about and may even drive through some of Mr. King's fields to get closer to the outcrop to be examined.

The outcrop occurs in the west valley-wall of Cedar Creek. It exposes several formations belonging to the Pennsylvanian System, lying <u>unconformably</u> on weathered limestone belonging to the Mississippian System. Glacial drift overlies the Pennsylvanian formations. An unconformity exists when rocks of different ages are in contact with a lost interval between them. The lost interval represents time during which there was either nothing deposited or material has been removed by erosion.

The Mississippian and Pennsylvanian Systems are only two of the fundamental units into which geologic time is divided (see accompanying classification), but rocks of these two ages are the only bedrock exposed in the Monmouth region. Rocks belonging to older systems are encountered in deep wells. Rocks belonging to younger systems may have been deposited in the area, but if so they were removed by erosion prior to the glacial period. This erosion developed on the bedrock formations a relatively level surface, called a <u>peneplain</u>. The valleys that existed in the region immediately prior to glaciation were incised in this peneplain.

At some localities deposits of a special kind of gravel are found on the peneplain surface and beneath glacial drift. This gravel is probably of Tertiary, possibly Cretaceous, age. It consists mainly of chert, quartz, and quartzite fragments, usually more or less rounded and polished or coated, and is generally more or less cemented. Pebbles of this character are common in the glacial drift immediately above the Pennsylvanian formations at this outcrop. They may indicate that a thin deposit of the "Tertiary" gravel is present, or they may simply have been included in the base of the glacier from deposits some distance away.

The formations in the Pennsylvanian System occur in sequences or cycles, called <u>cyclothems</u>. Each cyclothem seems to record a recession and a readvance of the seas in which most or all of the deposits were made. The accompanying diagram

shows the succession of beds in a cyclothem. However, rarely are all these beds found in any single cyclothem; usually one or more is lacking. More than fifty cyclothems have been identified in Illinois. At this stop only three are represented, as follows:

Pennsylvanian System	Ft.	In.
Seville Cyclothem		
Clay, noncalcareous, black and gray		6
Coal, brownish black		5
Siltstone, clayey, noncalcareous, soft, poorly bedded, fossiliferous, with <u>Stigmaria</u> sp., generally gray but black 2-4 inches at top.	4	9
Sandstone, micaceous, coaly, soft		1/2
Pope Creek Cyclothem		
Coal, iron-stained, flaky		3
Sandstone, carbonaceous, black, brittle, uneven, very fossiliferous with <u>Stigmaria</u> sp.; ave.		6
Underclay, very finely sandy, noncalcareous, micaceous, dark gray, poorly bedded; ave.	2	5
Sandstone, noncalcareous, micaceous, light gray, fine-grained, friable, massive, very unevenly bedded and unevenly laminated, with streaks of coal; within 75 feet grades laterally into shale, sandy, noncalcareous, dark gray, weak; average.	4	0
Babylon Cyclothem		
Coal, some sulfur and limonite stains	1	6
Underclay, sandy, micaceous, gray weak, with <u>Stigmaria</u> sp.	1	6
Sandstone, fine-grained, light gray, thinly and unevenly bedded, contains many plant fossils, thickness variable, averages.	4	6
Mississippian System		
Burlington Formation (weathered)		
Chert, varicolored, unevenly bedded residual from limestone, with sand and green clay in crevices, probably Pennsylvanian in age; average	3	0

The break or unconformity between the Mississippian and Pennsylvanian Systems at this exposure represents a long period of erosion. Elsewhere in Illinois there are several hundred feet of Mississippian formations above the Burlington.

Some if not all of these were deposited in the Monmouth region and were subsequently removed by post-Mississippian, pre-Pennsylvanian erosion. Also Pennsylvanian beds older than any present in this exposure occur elsewhere in the state, so that the time of their deposition is also locally represented in this break.

Return to Mr. King's farmstead.

0.5	15.8	Turn right (west).
0.3	16.1	STOP. Turn left (south).
0.6	16.7	Turn left (east) into Monmouth City Park.
0.1	16.8	Park cars in parking area.
		Stop 4. Lunch. After lunch leave parking area.
0.1	16.9	Turn right (north).
0.5	17.4	Turn left (west).
0.7	18.1	CAUTION. Railway crossing.
0.4	18.5	STOP. Rt. 67. CAUTION. Straight ahead.
1.2	19.7	Bear right and turn right (north).
2.0	21.7	Crossing Cedar Creek valley. Note that it is relatively narrow (less than half a mile) and that the valley walls are steep or even sheer cliffs.
0.3	22.0	Burlington Limestone forms cliffs on north side of valley.
0.1	22.1	Bear left (north).
0.3	22.4	Turn left (west) into entrance to Monmouth Stone Company quarry. Park cars on first "level" of quarry, on north side of entrance drive.

Stop 5. About 30 feet of the Burlington Formation are exposed through the three "lifts" of the quarry.

The Burlington Formation is typically a gray coarsely crystalline, crinoidal limestone, with more or less chert. The chert is not abundant in this quarry but is more abundant at some horizons and commonly occurs in irregular beds as well as in lenses and nodules. Locally the formation is a brownish or buff dolomite.

The limestone is relatively susceptible to solution, and crevices and channels created by solution, especially along joints, are not uncommon. Solution is also extensive on the

surface of the formation under the glacial drift that covers it. The fossils that are in the formation are more evident and more accessible on solution surfaces.

The most abundant fossils are the segments of crinoid stems, commonly known as "Indian beads," but the calyces or "heads" of crinoids and shells of brachipods also are common.

Stylolites, so termed because of their fancied resemblance to ancient writings with a stylus, are locally conspicuous. They appear much like sutures with sharp vertical lines and striations between adjacent beds of limestone. They are believed to result from differential solution, developing a special kind of interpenetration, of the adjacent beds.

The residue from solution of the limestone is a silty clay. Thin deposits of this clay occur at the tops and bottoms of the stylolite columns where it is greenish-gray in color. Where solution has been gross near the surface, the residual clay is stained yellow or red from the oxidized iron in it, and this material is known as <u>geist</u> (pronounced <u>gēēst</u>).

Above the limestone is glacial drift. The dark brick-red color of the lower part is unusual. It probably occurred not only because the drift is very weathered, but also because the glacier presumably incorporated within itself and subsequently deposited as part of the drift the red "geist" soil that had been developed on the limestone during the long interval of erosion between the Pennsylvanian and Pleistocene. The glacier also incorporated locally into the drift a percentage of the limestone which also weathered to red clay.

The high percentage of chert, quartz, and other resistant pebbles in the drift may again reflect the regional presence of "Tertiary" gravels. The age of the drift is presumed to be Illinoian, but it may be in part Kansan or even Nebraskan as the former is known to occur in the area and the latter also may be present. It is quite likely that even if the drift is all Illinoian in age, it originally included residues of the weathered older deposits such as will be seen at the next stop and which themselves are very red and full of residual pebbles of resistant rocks. This would be another factor contributing to the unusual character of the drift exposed at this locality.

		Return to highway. Turn left (north).
1.1	23.5	Turn left (west).
0.5	24.0	Turn right (north).
0.2	24.2	Turn left (west).
1.0	25.2	Cross bridge over Cedar Creek, turn about, and recross bridge.

Stop 6. Exposure of contact between the Burlington Formation and the underlying Hannibal Shale Formation in west valley-wall on north side of road.

Because the shale is relatively impervious, whereas the limestone is relatively porous, fractured, and partially dissolved, the groundwater that moves downward through the limestone is checked when it encounters the shale and tends to move laterally. Consequently, wherever there is opportunity, for instance where the contact of the two formations is exposed as it is at this locality, the groundwater will issue as seeps and springs. This landowner has taken advantage of this natural phenomenon to obtain a source of water for his stock.

Along the contact of the limestone and shale is a thin layer of dark greenish glauconite studded with minute crystals of pyrite or marcasite.

The valley of Cedar Creek is here considerably wider than it is at any place farther upstream. Reference to the Alexis Quadrangle topographic map well reveal that downstream from this locality the valley is more than a mile wide and that the valley walls are less steep than they are upstream. These conditions reflect the relative resistance to erosion offered by the different rocks. At this locality, farther downstream, and about a mile upstream, the stream is flowing on the Hannibal Shale which is much less resistant than the overlying Burlington Limestone and higher Pennsylvanian sandstones through which the stream flows upstream.

Here the contact between the Burlington Limestone and Hannibal Shale is several feet above stream level. Borings at the Monmouth Stone Company quarry show that the same contact is about 40 feet below the floor of the quarry. Inasmuch as Cedar Creek is only a few, probably not more than 10, feet lower here than at the quarry, the exposure of the contact here shows that it is several, possibly 30 or more, feet higher than at the quarry. This rise in the rock formations is not local but a part of a rise that extends all the way from the Lincoln structural up-fold at Pere Marquette Park and Alton in southwestern Illinois to the Savanna-Sabula Anticline or upfold at Savanna. At Alton the topmost formation is the Ste. Genevieve Limestone, the youngest formation of the Lower Mississippian Series and several hundred feet higher than the Burlington Formation. The oldest formation exposed at Savanna is the Galena, the next to youngest formation of the Ordovician System, which is several hundred feet below the Hannibal Formation.

Throughout this extent, formations of Pennsylvanian age lie unconformable on the older beds in succession. This relation shows that the uplifting of the older beds occurred after the Mississippian beds and before the Pennsylvanian beds were deposited and that the older beds were truncated by erosion at the same time.

0.9	26.1	Turn right (south).
0.2	26.3	Turn left (east).
0.5	26.8	Turn left (north).
1.6	28.4	SLOW. Road intersection. Straight ahead.
0.8	29.2	Hannibal Shale exposed in ditches.
0.2	29.4	Turn left (west).
2.1	31.5	Turn right (north).
1.8	33.3	Turn about at farmhouse.

Stop 7. Exposure of Loveland Silt over Yarmouth Soil on Kansan till.

The Loveland deposits are believed to have been deposited during the advance of the Illinoian glacier. Where they are overlain by Illinoian till they show no appreciable weathering. At this locality they are very weathered, presumably because the Illinoian till, if it was deposited above them, was eroded early so that the Loveland deposits have been exposed to weathering for a long time, possibly even in and since, the Sangamonian Sub-age.

Beneath the Loveland deposits Kansan till is exposed. On it there is a mature soil profile, developed by weathering during the Yarmouthian Sub-Age. Like the Sangamon Soil profile on the Illinoian drift, it displays the five instead of the three zones.

The red color of the weathered Loveland deposits and Yarmouth Soil profile is again probably due not only to the degree of weathering but also to the presence of an unusually large proportion of geist from the weathered local Burlington Limestone.

The degree of weathering also is exemplified by the condition of granite boulders in the Yarmouth Soil profile --- they are practically rotted to sand.

This stop concludes the trip. Rt. 67 may be reached by going 1.8 miles south and 4 miles east. Rts. 94 and 135 may be reached by going 0.8 or 1.8 miles south and 2 miles west.

END OF TRIP

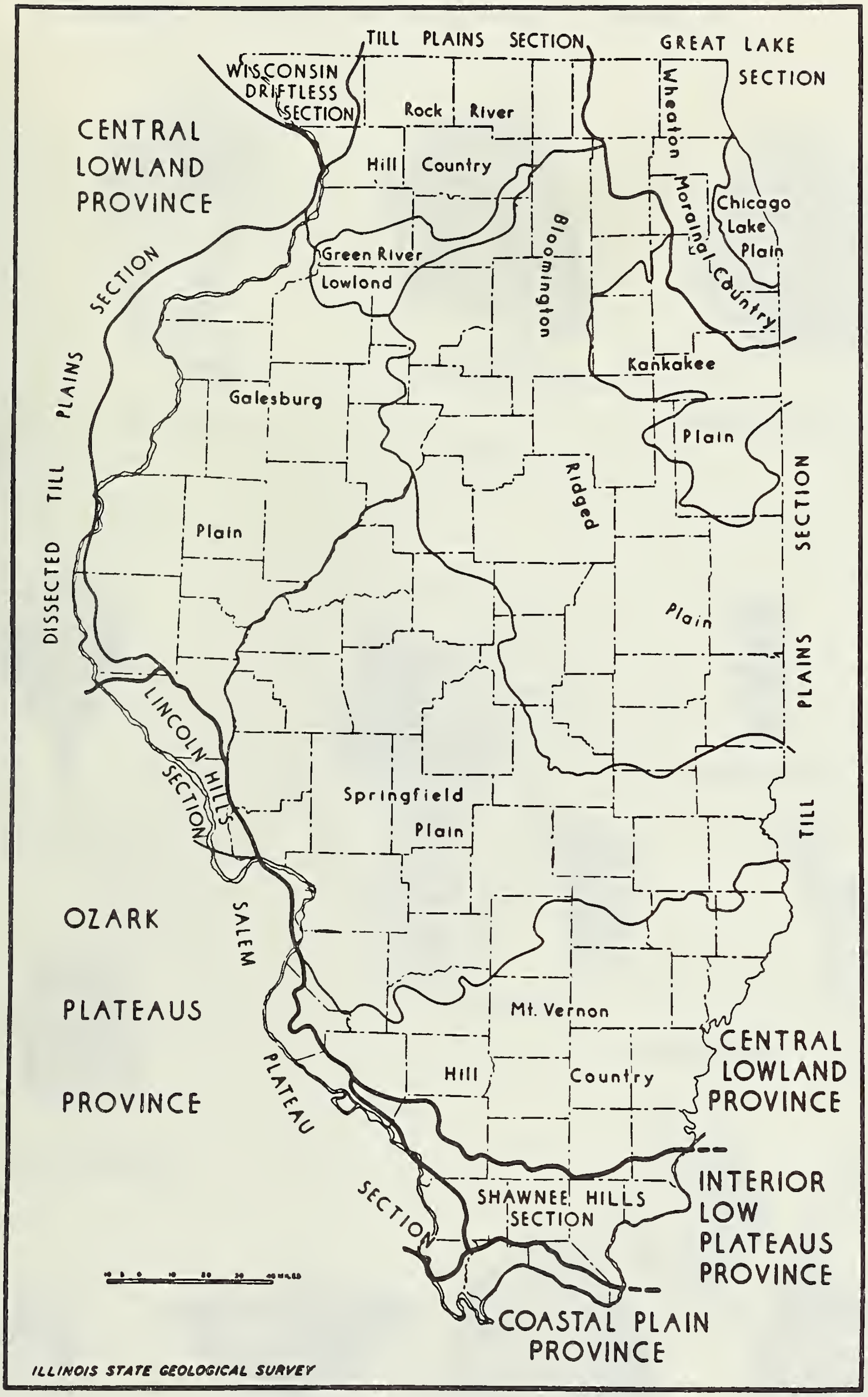
Revised January 1964

GENERALIZED GEOLOGIC COLUMN - MONMOUTH AREA

ERA	SYSTEM	SERIES	REMARKS
Genozoic	Quarternary	Pleistocene	(See detailed Time Table of Pleistocene)
	Tertiary	Pliocene Miocene Oligocene Eocene Paleocene	Stream gravels
Mesozoic	Cretaceous		Present in extreme southern Illinois only
	Jurassic		Not present in Illinois
	Triassic		Not present in Illinois
Paleozoic	Permian		Not present in Illinois
	Pennsylvanian		Sandstones, siltstones, shales, clays, and coal beds
	Mississippian	Chesterian	Not present in Monmouth area
		Valmeyeran	Burlington Limestone Hannibal Shale
	Devonian		Limestone and sandstone in deep wells
	Silurian		Limestone and dolomite in deep wells
	Ordovician		Shales, limestone, and sandstones in deep wells
	Cambrian		Dolomites in deep wells
	Precambrian		

Time Table of Pleistocene Glaciation
(after J. C. Frye and H. B. Willman, 1960)

Stage	Substage	Nature of Deposits	Special Features
cent		Soil, youthful profile of weathering, lake and river deposits, dunes, peat	
Wisconsinan	5,000 yrs. Valderan 11,000 yrs.	Outwash	Outwash along Mississippi Valley
	Twocreekan 12,500 yrs.	Peat and alluvium	Ice withdrawal, erosion
	Woodfordian 22,000 yrs.	Drift, loess, dunes lake deposits	Glaciation, building of many moraines as far south as Shelbyville, extensive valley trains, outwash plains, and lakes
	Farmdalian 28,000 yrs.	Soil, silt and peat	Ice withdrawal, weathering, and erosion
	Altonian 50,000 to 70,000 yrs.	Drift, loess	Glaciation in northern Illinois, valley trains along major rivers, Winnebago drift
angamonian 3rd interglacial)		Soil, mature profile of weathering, alluvium, peat	
llinoian 3rd glacial)	Buffalo Hart Jacksonville Liman	Drift Drift Drift, loess	Glaciers from northeast at maximum reached Mississippi River and nearly to southern tip of Illinois
armouthian 2nd interglacial)		Soil, mature profile of weathering, alluvium, peat	
ansan 2nd glacial)		Drift Loess	Glaciers from northeast and northwest covered much of state
ftonian 1st interglacial)		Soil, mature profile of weathering, alluvium, peat	
ebraskan 1st glacial)		Drift	Glaciers from northwest invaded western Illinois

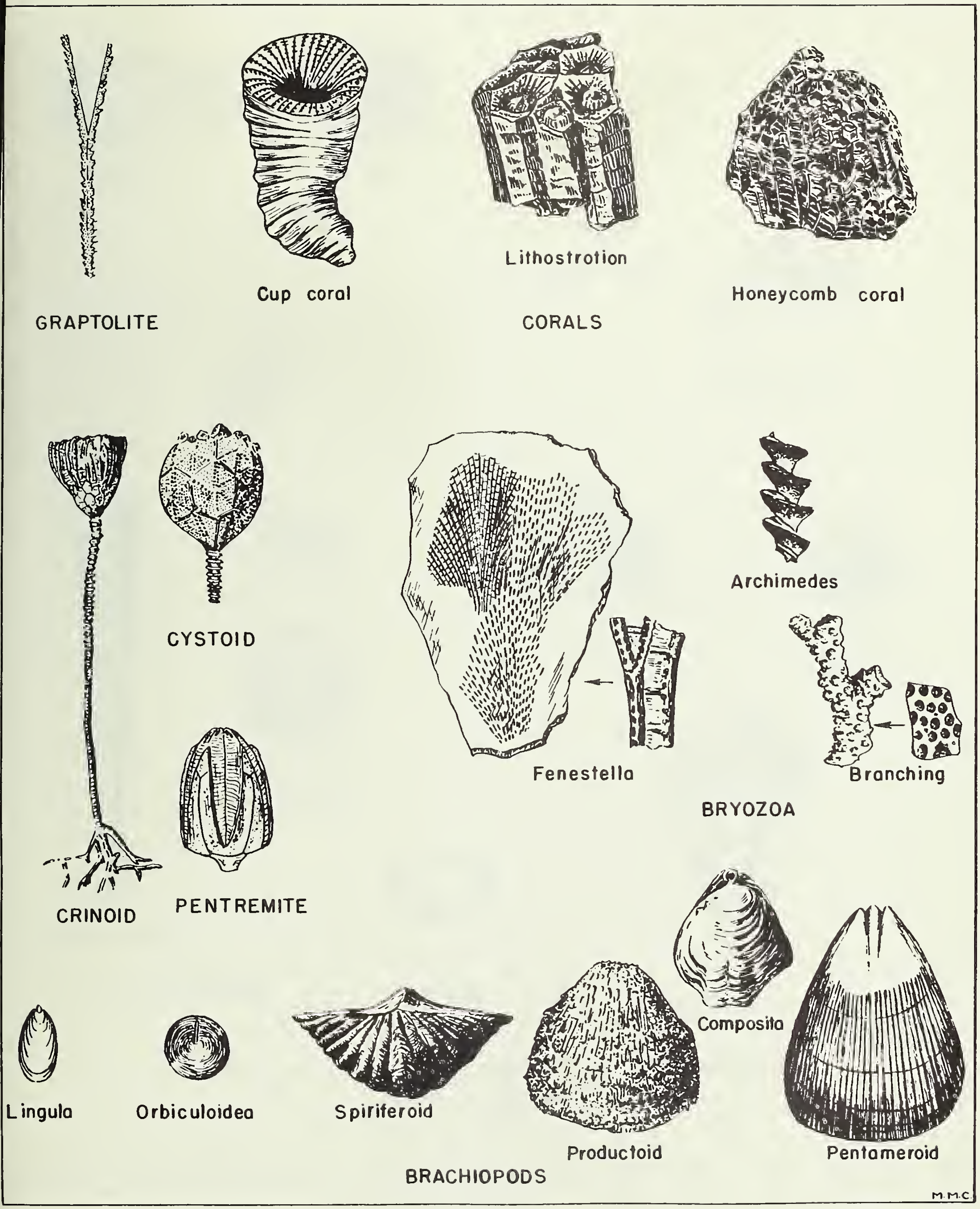


PHYSIOGRAPHIC DIVISIONS OF ILLINOIS

(Reprinted from Illinois State Geological Survey Report of Investigations 129, "Physiographic Divisions of Illinois," by M. M. Leighton, George E. Ekblaw, and Leland Horberg)

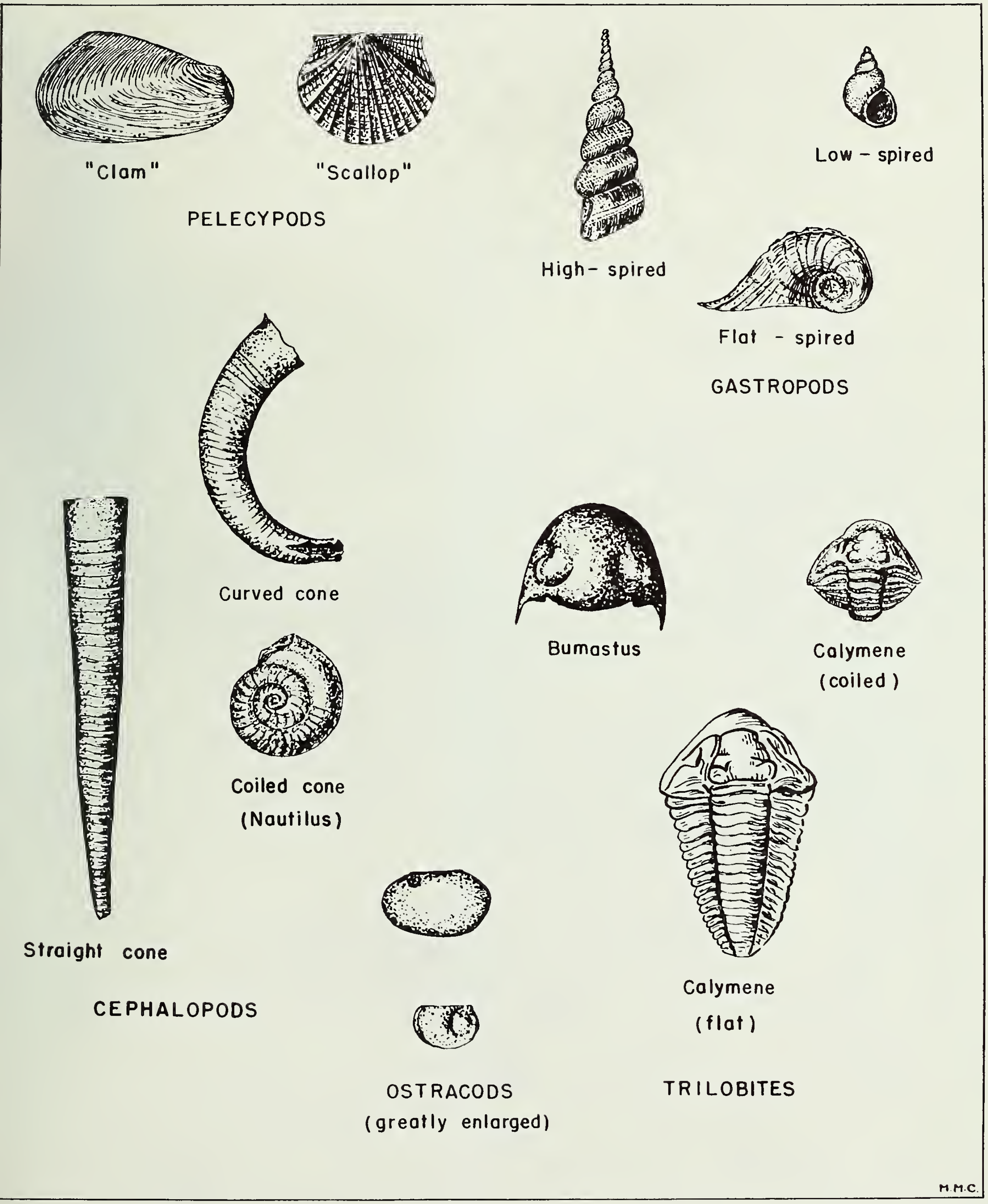
(7669–15M–11-61)

Common Types of Illinois Fossils



(55757—25M—5-62)

COMMON TYPES of ILLINOIS FOSSILS



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